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ABSTRACT

The Direct Reading Lesson, as discussed in this article, is a method that allows for improving reading skills in math. The author suggests the following steps for using expository material: read for main idea; read for sequence or outline; note vocabulary; refer to illustrations and diagrams; read creatively, inferring, drawing conclusions, and seeing relationships; solve problems; and review. Guiding students through these steps will enable them to improve their skills in reading the language of mathematics. (MB)

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"READING PATTERNS IN MATHEMATICS"

A Paper presented at the Twenty-Second Annual Convention of the International Reading Association

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READING PATTERNS IN MATH

Many students in math classes may not be finding success due to their inability to read their math textbooks. As math teachers or a teacher of any subject area, it is the instructor's responsibility to teach students how to read their subject textbook. Reading skills need to be developed before mathematical skills can be thoroughly learned.

Students do have difficulties with math terms because the term may have a different meaning in mathematics than in general usage and the term may not be related to anything the student is familiar with. It is important that students realize that math problems can be stated in different ways and can be translated into mathematical symbols that they are familiar with. For example, the following statements have the same meaning:

Example 1

two plus two is four
the sum of two and two will be four
two increased by two is four
two and two equals four
two added to two gives you four
$2 + 2 = 4$

Example 2

Eight less than six times some unknown number is sixteen
the product of six and some number decreased by eight is 16
six times some unknown number less eight is sixteen
the product of six and some number reduced by eight is sixteen
$6n - 8 = 16$

Teachers should emphasize the different ways an operation or mathematical symbol can be represented.

Students also need to be made aware of the speed with which they read. In math it is necessary to read at a slower rate in order to note details, to organize the information, draw conclusions, solve problems, and then check the solution. The instructor should also stress reading and re-reading expository material. The Directed Reading Lesson for Expository Material is one method for improving comprehension in mathematics. This method requires the student to follow a step by step procedure which emphasizes each aspect of the written material. If the teacher explains the material instead of asking the student to read it herself, then the student will grow dependent on the teacher and will not be able to interpret the material herself. However, many students just are unable to interpret the material by themselves. This is one of the major excuses for their dependency on the teacher. It is the teacher's job to guide the student's reading instruction. They must work together to make the textbook material comprehensible.

The following is this author's adaptation of the points suggested in The Improvement of Reading[1] for the directed reading lesson using expository material.

1. Read for main idea
2. Read for sequence or outline
3. Note vocabulary
4. Refer to illustrations and diagrams
5. Read creatively, inferring, drawing conclusions, and seeing relationships.
6. Solve problems
7. Review

[1]Constance M. McCullough, Ruth Strang, Auther Traxler, The Improvement of Reading. (New York, McGraw Hill Book Co.,1961), chapter 7.

Reprinted from:

Payne, J.N., et al. Algebra One. New York: Harcourt, Brace and World, Inc., 1969, p.66.

2–5 Addition of Real Numbers

Negative numbers often occur in applications. For example, if a plane is traveling 400 miles an hour into a head wind of 80 miles an hour, the ground speed of the plane is $400 + (-80)$. To solve such a problem and find the answer as 320, you need to know how to add positive and negative numbers.

The examples below show how the postulates of addition can be used to find sums. The sign for addition, +, is written in color for a while to stress that it is the sign of the operation.

Sum of Two Negative Numbers

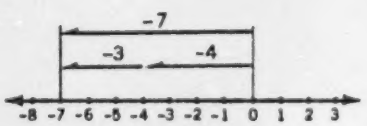
EXAMPLE 1. Find the sum of -4 and -3.

Think of -4 as a "loss of 4" and of -3 as a "loss of 3," as shown in the vector diagram.

Loss of $(4 + 3)$

$\downarrow$

$(4 + 3)$, or -7



The sum of -4 and -3 is -7.

Draw vector diagrams for each true sentence below. Can you discover a pattern?

a. $-5 + (-7) = -12$ b. $-6\frac{1}{2} + (-8\frac{1}{2}) = -15$

DIRECTED READING LESSON FOR EXPOSITORY MATERIAL

Consider the selection "Addition of Real Numbers" from Algebra I, by Payne which is published by Harcourt, Brace, and World, Inc. How would students read this material? The following procedure is suggested for improvement of reading skills.

1. What is the main idea?

   The title suggests that it is necessary for students to know the meaning of a real number. This includes knowing the use of signed numbers (positive and negative numbers) and how to work with them in the mathematical operation of addition.

2. What is the sequence of the content?

   -The title gives the topic for the section.

   -The first paragraph gives examples of the uses of signed numbers.

   -The second paragraph explains that the color of red will represent the operation of addition. If the student goes directly to the algorithm he or she would have missed this explanation as well as the topic of the section and necessary vocabulary words.

   -In the illustration a generalization for adding signed numbers is explained with the use of a vector diagram. Written problems are given to be solved with the use of vector diagrams.

3. List vocabulary words that are unfamiliar:

   Do students know the meaning of negative numbers? How is the word applications used in mathematics? Both negative and applications have ordinary English meanings as well as mathematical English meanings. What is head wind and ground speed? How does it relate to flying speed? The word postulate (rule) also needs

to be understood. Other vocabulary words include positive, sums, vector, and diagram.

4. Note the diagram:

   a. What is a vector diagram and what is its purpose?

      The vector diagram is a model using directional arrows that helps to establish the generalization of how to add negative and positive numbers.

   b. How do you read the diagram?

      The student needs to learn the direction his eyes move while changing his attention from expository material to illustrative material.

5. What conclusions can be reached?

   -The uses of signed numbers include travel, situations which involve loss and gain, technicalities of sports, money, and the rise and fall of stock quotations.

   -Based on the vector diagram, a generalization can be decided concerning the procedure used to add two negative numbers.

6. Solve problem:

   Students should perform necessary operations to solve problems based on conclusions drawn in part five.

7. Review:

   Review the solution to see if answer is reasonable.

The method of employing the directed reading lesson depends on the level of students involved. At first, teachers should guide the students and together they should examine the material and consider each of the seven aspects of the procedure.

After practice, the students should be asked to do the procedure alone. Low level students should be required to write the answers, while the higher level student could study the material and answer the questions to himself or orally if done as a group assignment.

The use of the directed reading lesson is very important when teaching students to develop skills necessary to comprehend expository material. Guiding students through these steps will enable them to become confident of their ability to learn how to read their math material.

A different procedure is required for solving verbal arithmetic problems, than when reading expository material.

Consider the following procedure for solving word problems (verbal arithmetic problems). It is suggested by A.C. Maffei's article, "Reading Analysis in Mathematics."

DIRECTED READING LESSON FOR VERBAL ARITHMETIC PROBLEMS

Problem: Find three consecutive integers such that if three times the smallest is decreased by the sum of the other two, the difference between them will be 46.

1. Preview:
   a. First reading of problem
   b. List unknown words and phrases for possible discussion.
      1. consecutive
      2. integers
      3. decreased
      4. sum
      5. difference

2. Question:
   a. Second reading of problem
   b. Write direct question of problem
      Find three consecutive integers

3. Read:
   a. Third reading of problem
   b. List all word facts of problem in some logical order:
      1. 3 times the smallest
      2. decreased by the sum of the other two
      3. the difference will be 46

4. Reflect:
   a. Fourth reading of problem
   b. What is x, the unknown quantity representing?
      Let x = the 1st consecutive integer; therefore, the three consecutive integers will be x, x + 1, and x + 2.

   c. Translate word facts into algebraic facts with the use of x:
      1. $3x$
      2. $-(x + 1 + x + 2)$
      3. $= 46$

5. Rewrite:
   a. Rename algebraic facts in terms of a balanced equation and then solve for x:

      $3x - (x + 1 + x + 2) = 46$
      Solving the problem we find $x = 49$. Therefore, the three integers are 49, 50, and 51.

6. Review:
   a. Substitute the value of x into the equation and check.
      $3(49) - (50 + 51) = 46$
   b. Does the problem make sense in terms of the question?
      Yes, because 49, 50, and 51 are three consecutive integers that will meet the conditions of the problem to give you the needed solution of 46.

DIRECTED READING LESSON FOR VERBAL ARITHMETIC PROBLEMS

EXAMPLE NUMBER 2

Problem: A family is making a monthly mortgage payment of $92.50. They were told that $59.20 was for interest and principal, $3 per month for the fire insurance policy, and the rest for taxes. How much per month are they paying in taxes if this amount is $92.50 decreased by the sum of the interest amount and the fire policy amount?

1. Preview:
   a. 1st reading of problem
   b. List unknown terms
      1. Mortgage
      2. Payment
      3. interest
      4. principal
      5. insurance
      6. policy
      7. taxes
      8. decreased
      9. sum

2. Question:
   a. 2nd reading of problem
   b. Write direct question of the problem
      How much per month are the taxes?

3. Read:
   a. 3rd reading of problem
   b. List all word facts of problem
      1. amount of taxes is $92.50 decreased by
      2. the sum of the interest amount and the policy amount

4. Reflect:
   a. 4th reading of problem
   b. What is x, the unkrown representing?
      x is representing the amount of taxes paid each month.
   c. Translate word facts into algebraic facts with the use of x.
      1. x = $92.50 -
      2. ($59.20 + $3)

5. Rewrite:
   Rename algebraic equations in terms of a balanced equation and then solve for x:

   x = $92.50 - ($59.20 + $3)
   x = $92.50 - $62.20
   x = $30.30

   The taxes are $30.30

6. Review:
   a. Substitute in value and check
      $30.30 = $92.50 - ($59.20 + $3)
      $30.30 = $30.30
   b. Does the problem make sense in terms of the question? Yes.

Modification of Eye Movement Patterns

You may have noticed that when we looked at the directed reading lesson for the expository material there was reference of how to read the diagram. Eye movement patterns in math may be totally different from the basic pattern students have been taught to employ. The most frequently used eye movement pattern is from left to right from the beginning of a line of print to the end. This pattern is frequently inappropriate in the perusal of a math text which is heavily interlarded with an assortment of illustrative material. This necessitates leaving a line of print to check on the translation of the verbal description into an algorithm, diagram, table, or illustration, returning to the print, frequently in the middle of the line, and so on. Additionally, many diagrams require a right to left eye movement for portions and a right to left eye movement for other sections. Students often read an algebraic equation across the numerators rather than from top to bottom as is required when a fraction is involved. You might be surprised at the eye movement pattern of non-verbal material. Ask some of your weaker students just to read an equation. Number lines involving negative numbers going from right to left also can cause reading problems.

Once again consider the selection "Addition of Real Numbers" from Algebra I, by Payne. How do your eyes move as you read this material? Do they read in the usual order of left to right and from top to bottom?

Emphasize that more than one correct eye movement pattern may exist. Students need to be aware that an incorrect eye movement pattern may lead to the wrong interpretation of expository material. The following sequence explains an example of a possible eye movement pattern that may be experienced while reading "Addition of Real Numbers."

EYE MOVEMENT EXAMPLE #1

First, the title, two paragraphs, and example are read from left to right. Next, the eyes need to divert to the vector diagram. The diagram is read by looking at the bottom line and then moving the eyes upward toward the second line. The directional vectors which denote "loss of 4" and "loss of 3" are found by moving the eyes from right to left. The student then proceeds to the expository material written to the left of the diagram which is of a different column width. After reading the first line from left to right, the student should notice the vertical arrow that the publisher has placed in the material. This arrow is there to help students be aware of the relationship between the mathematical term loss and the mathematical symbol $^-$. Reference is then made to the diagram to locate the vector which denotes "loss of 7." This is read from right to left, then the student refers to the summary statement which restates the generalization inferred by the diagram. The problems written at the bottom of the page are stated in the basic reading pattern of left to right. However, this may create a problem for some students as math problems are frequently written in columns which are read from top to bottom.

While students are reading the material it is possible that they may not be aware of the importance of details that are included in parts of the expository material. It is the duty of the instructor to help students alleviate this situation by making reference to important aspects of the reading material.

EYE MOVEMENT EXAMPLE #2

Another difference in eye movements in mathematics is that problems are solved in a specific order that is not always from left to right. Consider the phrase $6 + 2 \cdot 4$. (Do students know what a phrase is? What does the raised dot mean?) If this were to be simplified in order to find a common name, many people would get the answer of 32. (Do they know what a common name is?) This is an incorrect answer. The rule for "Order of Operations" indicates that you multiply or divide before you add or subtract. Therefore, to do this problem you need to work on the right end of the problem and then on the left side. The correct answer is 14. If the phrase had been written in this manner: $6 + (2 \cdot 4)$ the operation inside the parentheses (multiplication) is done first and once again the answer is 14.

Consider the problem $35 - 24 \div 6$. The division is done first which means that once again the student must work from the right side and then the left. The correct answer is 31.

SUMMARY

The progress of a student depends on teacher awareness and classroom implementation of methods to improve weaknesses in reading skills. There is a need for the teacher to employ skills to teach the students how to interpret expository and illustrative material and verbal arithmetic problems.

The Directed Reading Lesson, as discussed in this article is a method that allows for improvement in reading skills in math by emphasizing the important details through a series of steps in the procedure. It is important that the students by guided through these steps. The student and teacher must work together. Students need to practice the procedures and become skilled at reading and interpreting the material he finds in his subject textbook. Ask them to take their share of the responsibility required to improve their skills in reading the language of math. Teachers need to be responsible to the student by stressing the need that they be aware of their eye movements and changes in reading direction.

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